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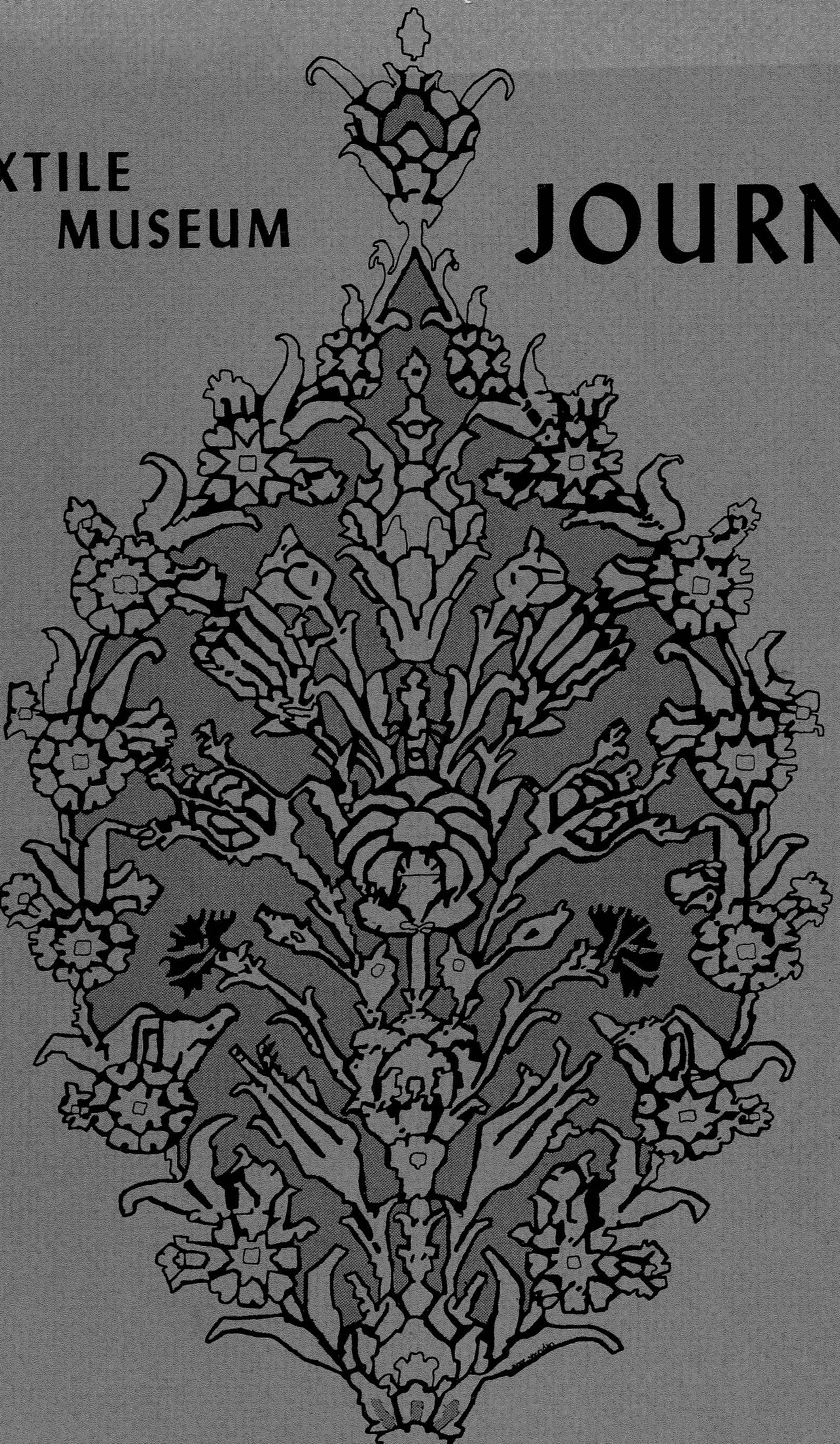

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COVER: Drawing by Anne Sheridan of the large floral oval wreath designed in the center of Textile Museum's "Benguiat" Ottoman prayer rug, 1967.24.1 (Figure 13 in Charles Grant Ellis' article "The Ottoman Prayer Rugs").

DRAWINGS for Color-relationship Chart and illustrations for "How to Match Colors when Dyeing Yarns or Fabrics for Textile Conservation Purposes" by Col. James W. Rice are by Dianne Sisko.
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A PRACTICAL DYEING METHOD FOR THE FABRIC CONSERVATOR

THEODORE R. COOLEY

The professional dyer of today, unlike his medieval counterpart, is a highly trained scientist, a chemical engineer and a colorist all combined. The technical competence required of a professional is usually well beyond the ability of the average fabric conservator. Yet, numerous occasions arise where the fabric conservator must reproduce matching or harmonizing colors or hues in background fabrics and/or in matching yarns of the textiles being restored.

Extremely satisfactory results can quite readily be achieved by an understanding of a few simple principles and an awareness of the limitations imposed on the conservator by space, equipment and cost. Unless he is very fortunate, he will find it nearly impossible to locate a competent commercial dyer who will undertake relatively small jobs or, having located a commercial dyer, he will find that the cost is prohibitive. To add to his woes, few dyers will guarantee to produce the precise shade, hue or color intensity desired.

Excellent results can be obtained by an educated "trial and error" approach which will, in 95% of the cases, meet the practical needs of the conservator, provided he has what is known as "color sense." Without this, even the professional dyer is lost as there are over 10 million recognized color variations said to be discernible by trained colorists. Indeed, this "color sense" was the chief stock in trade of the medieval dye master who produced the thousands of colors and shades found in old tapestries and ancient fabric artifacts.

Despite the precision of modern science, even the professional dyer cannot guarantee spectrographic exactness from one dye lot to the next, which is the reason one must always purchase enough yarn or fabric from the same dye lot to complete a project.

What is proposed here is a relatively simple and practical procedure whereby the fabric conservator can obtain satisfactory dyeing results without a chemical engineering degree and with a minimum of equipment—much of which will already be available in the conservator's own laboratory.

First, a few elemental principles of the physics of light should be recalled. Color can be described in two ways: additive or subtractive. The first concerns the physicist; the second the dyer or colorist. The color red can be described as the absorption of all the light energy excepting the red portion of the spectrum. Or it can more simply be described as the reflection of the red portion of the spectrum. Black is the absorption of all the radiant light energy, and white the reflection or non-absorption of all the radiant light energy. However, like absolute zero, absolute white and absolute black can be approached but never quite attained. The same is true of the three primary colors: red, blue and yellow. It is nearly impossible to obtain a spectrographically pure primary color dye powder.

Inasmuch as dyes are subtractive in nature, there is no such thing as a white dye. White in a fabric, or a yarn, must be obtained by either bleaching out all those elements which absorb light energy, or by coating the material with a substance which reflects all light energy.

So much for the few elements concerning the physics of light.

Regarding color, one can state that all color is composed of three primary hues: red, blue and yellow. In theory, any color, hue or shade can be produced by one of the primaries or by a combining of the primaries. In theory, black is the product of equal parts of the three primaries. In practice, however, this is not true and the usual result of combining the three primaries is a grey. This is due to the fact stated above that it is nearly impossible to obtain a spectrographically pure red, blue or yellow and, also, due to the fact that, usually, the primary dye colors are of different strength or potency. Hence, the beginning dyer would be advised to obtain not only the three primary colors but also to purchase a black dye powder which has the added advantage of being used to "grey down" a color—a procedure which the fabric conservator will find useful in working with old and faded fabrics.

The beginning dyer would be well advised to confine his first attempts to the dyeing of the natural fibers or fabrics. The dyeing of snythetics can become extremely complex and difficult. (As most of the conservator's work will be with old fabrics, the dyeing of natural fibers or fabrics is a corollary to such work.) However, the natural fibers fall into two classes: the protein fibers and the cellulose fibers. Wool, silk, hair and other animal products comprise the protein fibers. Cotton, linen, ramie, all the bast fibers and other fibers of the vegetable kingdom comprise the cellulose group. Rayon, being of cellulose extraction, falls into the latter grouping. Hence, two totally different types of dye powders must be obtained. Two of the simplest dye powders to use are the CIBA Benzyl and the CIBA Chlorantine for the protein and the cellulose fibers respectively. Both will produce a fast dye and both are equally easy to use. Neither requires a mordant to obtain fastness. Both are water-soluble and the aqueous solutions can be stored for considerable periods without deterioration. The benzyl dye is a weak acid dye and uses dilute acetic acid (vinegar) for an assist. The chlorantine dye is a direct dye and uses common table salt (Sodium chloride) as an assist. The dyeing with both types of dyes is done in a hot water bath—the water being raised from blood temperature to just short of the boil (212° F.) while agitating the yarn or fabric to obtain evenness in dyeing.

Inasmuch as the fabric conservator is usually concerned with "matching" a color, or in obtaining a certain shade or hue, he may find that "kitchen" dyeing will suffice for his needs. "Kitchen" dyeing is simply using equipment which is normally found in a kitchen: teaspoons for measuring, ounces, pints or quarts for volumetric measurements, a set of kitchen scales, etc., as against the precise equipment usually found in a laboratory. In "kitchen" dyeing, the dyer proceeds somewhat irrationally and is guided solely by his color sense and an instinct for the relationship between his three primary colors. The results of his work are not always predictable nor reproducible and his approach would probably make a colorist chemist shudder. However, for occasional dyeing and for small lots where reproducibility is of secondary importance, "kitchen" dyeing can produce surprising results with a minimum of effort and equipment. Almost invariably, however, the "kitchen" dyer changes over to the use of more precise procedures.

Following are two lists of equipment needed for dyeing—one by the "kitchen" method and the other by the "precision" method:

Equipment for kitchen dyeing

Spring scales accurate to ¼ oz.

Kettle for boiling material—glass, stainless steel, agate or granite ware, Pyrex. A canning kettle is good.

Small glass stirring rods.

Large turning rods to turn fabric or yarns. Wooden dowel rods covered with plastic tubing are good.

Set of measuring spoons, plastic or stainless steel.

Measuring cup, 8 oz. or more.

Quart jars to store stock solutions.

Thermometer, liquid immersible.

Equipment for precision dyeing

Balanced scales accurate to 1/10 gram.

Pot for boiling material. Glass or stainless steel is recommended.

Small glass stirring rods.

Large turning rods, preferably glass. These can be made from glass towel racks—straightening the angled ends in a flame. ½″ or larger glass rods may be purchased and sharp ends smoothed in a gas flame.

100 ml graduate.

100 ml pipette or disposable hypodermics 10, 2½, and 1 c.c.

Thermometer accurate to 212° F.

pH paper.

Storage bottles.

Equipment needed for both methods of dyeing

1. A source of heat to raise the temperature of the dye-pot from 100° F. to a simmer in not more than 30 minutes. The size of the heater, like the size of the dye-pot will be determined by the amount of material which is to be dyed.
2. Storage bins for bottles of stock solution. A plastic dishpan is good for such storage.
3. Neutral detergent for use as a "leveler" to prevent the dye from being absorbed too quickly.
4. A sink or large kettles for "wetting out" and rinsing materials.
5. Miscellaneous items such as tags, record book, labels, and so forth.
6. CIBA dye powders in at least the three primary colors, plus black, in both the benzyl and the chlorantine types for protein and cellulose fibers respectively.
7. Non-iodized common salt.
8. Acetic acid 56% strength.

PROCEDURE

To prepare dye solution:

1. Carefully weigh the dye powder. 10 grams of dye powder in 1 liter of water will make a 1% solution. Two hardpacked and leveled teaspoons of dye powder in 1 quart of water will make a 1% solution by the "kitchen" method.
2. Add a little water to the dye powder and mix thoroughly into a smooth paste.
3. Add boiling water to the paste to make a liter or a quart of solution, making sure that all the dye powder or paste is included in the solution. Shake the container until the solution is clear.
4. Keep covered tightly until ready to use. If the dye stuff precipitates, place the storage bottle in a hot water bath and heat to redissolve.
5. Prepare the acetic acid assist for use with protein fibers by making up a 10% strength solution. A dye bath with a pH of 5-6 is desirable for dyeing animal fabrics.

Steps in the dyeing procedure:

1. Remove all soil from the material and thoroughly "wet out" the fibers. Use warm water which has been "softened" and a neutral detergent to remove the soil.
2. Prepare the dye-bath, using the correct "liquor ratio", which is the weight of the liquid in the dye-pot in ratio to the weight of the dry material. A 20:1 liquor ratio would be a liquid weight of 20 times the dry weight of the material to be dyed. A 20:1 ratio is used for strong colors and a 30:1 to 40:1 for light or pastel shades. Be sure the dye pot is large enough to give this ratio.
3. Use distilled or softened water for the dye-bath, heated to about 100-110° F. Add the desired amount of the dye-stock solution to the water and also add the assist. (The acetic acid solution for protein fibers and salt for cellulose fibers.) Use about 10% of the weight of the dry material in salt as an assist for cellulose fibers. Use about 10

to 15 c.c. of the acetic acid assist per pound of material. The quantity of assist used can be varied. The more assist used, the faster will be the absorption of the dye into the material—AND—the more chance of uneven dyeing. More assist can be added, if needed, during the dye process.

4. Raise the temperature of the dye bath to a simmer in 30 minutes. Simmer for 30 minutes longer. Add more assist as needed to clear the bath. NOTE: when dyeing cellulose fibers, the dye bath may not clear. Do NOT raise temperature too fast as that will cause uneven dyeing. Rotate the material while raising the temperature to prevent uneven dyeing.

5. Cool the material in the dye bath slowly with water or allow it to remain in the bath until temperature is lowered below 80° F. Rinse thoroughly and allow material to dry.

A few practical hints to observe in dyeing:

1. Carefully weigh the dry dye powder.
2. Carefully measure out the water used to make the dye solution.
3. Accurately weigh the dry material or yarn.
4. Make certain the material or yarn is thoroughly "wet out". Overnight soaking is not too long for linen and the other bast fibers.
5. Do not use chipped enamelware.
6. Thoroughly clean all measuring equipment and containers.
7. Use as pure water as is available. If water is more than 5 grains hardness, use a very small amount of Calgon (a trade-marked product) as softener.
8. Be sure that the dye-pot is large enough to give the needed "liquor ratio".
9. Agitate the material being dyed while raising the temperature. By agitation is meant a "turning" of the material rather than a stirring.
10. Thoroughly "scour" yarns which are "in the grease" and bleach out "greige" goods for best results. Gray goods will result in a muddy and unpredictable color.
11. Keep accurate records and samples of "before and after" dyeing a material. They are excellent in determining which way to go on subsequent dyeings.
12. When dyeing yarn, always tie it in skeins for ease of use afterwards.
13. CIBA dyes give clear, bright colors in the primary shades. The secondary shades are a little less brilliant and the tertiaries likewise. Graying can always be done by the addition of black or by adding a bit of the third primary to a secondary color.
14. In experimenting with the dyes it is best to start with a primary, and either of the other colors and then the third color, which will give, respectively, a secondary hue and then a tertiary.
15. In comparing colors, always make the comparison under natural light. The same material will have a different hue under incandescent light and still another hue under fluorescent light. Beware of making color comparisons where the surroundings can cast a reflection on the material. A red brick wall will impart a red tone to a color.
16. Agitate or rotate wool as little as possible when raising the temperature of the dye bath. Too much agitation will "felt" wool.
17. Inclusion of a few strands of yarn on a leader, or a few scraps of cloth on strings in the dye bath with the material being dyed will give the dyer an indication of the shade of the material in the pot. By extracting these indicators and pressing them dry, one gets an idea as to how intense the color is on the material being dyed. The wet material will always be darker than when it is dry—sometimes as much as four or five shades. In dyeing to match a color, it sometimes helps to wet out the control sample with water and compare (roughly) with the color of the material in the dye-pot. The dyeing process can be stopped at any point by removing the material from the pot and then bringing it to a simmer in water containing assist. However, such a procedure may result in an uneven dye job. It is better to go light on the dye solution and add more solution as needed by dropping the temperature below 150°F. and then adding more solution.

In conclusion, it must be stated that dyeing—particularly for the occasional dyer—is an art and not a science. Much "trial and error" must be indulged in to obtain a modicum of proficiency and the amateur dyer must have a good deal of patience. It is, however, a very fascinating subject and one which is rewarding, if for no other reason than the beautiful and oftentimes dazzling hues which sometimes emerge from one's mistakes.

One of the big drawbacks which, in the past, has inhibited the amateur from indulging in this art has been the unavailability of a source of small quantities of dye powders. The dye manufacturers will gladly sell a barrel of one shade of dye powder but they scorn the order for a few ounces. This has been rectified by the Countryside Weavers of Mission, Kansas, who buy dye powder by the barrel and sell it by the ounce. They stock the three primary colors plus black in both the benzyl and the chlorantine dyes, plus several of the secondary dye powders such as green, purple, orange, and a few of the tertiary colors.

For those interested in pursuing this art, the author would recommend "Color and Dyeing" by Harriet Tidball. This is a Shuttlecraft Guild Monograph Sixteen of 1965 distributed by the late Harriet Tidball herself, and also through the Craft and Hobby Book Service, Big Sur, California, for $5.00. This author attended a summer course in dyeing at the Philadelphia College of Textiles and Technology with Harriet Tidball and can attest to her competence. The recommended Monograph was written primarily for handweavers to enable them to dye their own yarn but the principles, laid out in much greater detail than can be presented in this article, are applicable and useable by anyone interested in doing dyeing either of yarn or cloth.